PATENT SPECIFICATION

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Sterilization Method and Apparatus

We, THE BENDIX CORPORATION, a corporation of the State of Delaware, United States of America, of The Fisher Building, Detroit, Michigan, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method and appartus for inactivating and killing microorganisms such as germs and more particularly to a method and apparatus for microscopic cleaning and sterilizing bacteria contaminated articles by the utilization of cleaning solutions, the cavitational action of sonic energy and a bactericidal gas.

An object of the present invention is to provide a method and apparatus for the microscopic cleaning and sterilizing by the combined use of a detergent cleaning solution, the cavitational action of sonic energy and a bactericidal gas.

Another object of the present invention is to provide a gas sterilization method and apparatus for microscopic cleaning and sterilizing bacteria contaminated articles which may be accomplished rapidly and economically.

Present methods of killing microorganisms or sterilization of articles include the method of utilizating germicidal solutions, the cavitational action of sonic energy and autoclaving as disclosed in our co-pending application No. 32171/61 (Serial No. 947,699). The method disclosed therein is an improvement over the methods which utilized liquid treatment. The present method is an improvement over the methods of sterilization which utilize gas treatment. The present gas treatment methods include the use of gas chambers, autoclaves, and flame sterilization. These methods have several drawbacks in the killing of microorganisms, which drawbacks include the incomplete sterilization of the articles, the inadequate physical cleaning of the articles and the degree of heat and pressure required. A further object of the invention is to provide an economical method and apparatus which advantageously incorporates the features of a cleaning solution, sonics, and a bactericidal gas and utilizes the inter-reaction of each feature.

Microorganisms may be classed in two groups; those which form clumps or chains and those which do not group in this fashion. Microorganisms and in particular bacteria are found in either of these two groups. A small percentage of the bacteria found are spore forming bacteria types which form a resistant coating and thereby become more difficult to kill. Most present methods of killing bacteria and sterilization of articles are capable of killing the non-spore forming type bacteria but have substantial difficulty in killing spore forming types. A still further object of the present invention is to provide a method and apparatus which kills the microorganism cells regardless of its grouping and type.

The invention may advantageously be utilized in the cleaning and sterilization of medical and dental clinical instruments. Instruments of this type have been found to be the most difficult to clean and sterilize because of the material deposited on the instruments and the type of bacteria which are present. The bacteria will in part be the spore forming type and may be encapsulated by various residues present in clinical environments such as dried blood, bone, enamel, or dentine. Present methods of killing the bacteria and cleaning contaminated articles of this type are time consuming and are not economical. In present methods where sonic energy is utilized, the sonic

energy is applied through a fluid medium producing compressional wave energy without cavitation. Sonic energy applied in this manner kills the bacterial cell by rupturing and has substantial difficulty in reaching all of the bacteria cells. Conversely, the invention utilizes the sonic energy by applying the energy to a cleaning solution at a frequency and power to produce cavitation. The invention combines the use of a cleaning solution, sonic energy and a bactericidal gas and utilizes their inter-reaction. The usefulness of the invention will therefore be apparent in the sterilization and cleaning of medical and dental instruments which must be microscopically clean and bacteria free.

The cleaning solution of the invention comprises a wetting agent which may be a detergent, and water. The sonic energy applied at a lower and frequency sufficient to produce cavitation of the cleaning solution, and the wetting agent-detergent combine to effect a deagglomeration of the foreign encapsulating material and bacteria on the article to be sterilized and to effect a normal cleaning action on the article. Heretofore gas sterilization was not possible on metallic articles, or articles which include foreign encapsulating material on them and such method of sterilization was limited to articles which could not be sterilized by liquid methods. The liquid methods are almost mandatory on articles coated with encapsulating materials because the gas method will not penetrate the material. In the present invention the encapsulating materials are removed prior to exposure to the bactericidal gas thus making the decontamination possible. Obvious advantages of the present invention will be hereinafter apparent in that the method does not require pressures or temperatures for successful operation.

A still further object of the invention is to provide a method and apparatus for cleaning and sterilizing whereby the sonic energy applied at a frequency and power sufficient to produce cavitation to a cleaning solution, increases the cleaning and deagglomeration action of the cleaning solution and improves the sterilization result of the gas sterilization process while reducing the time of the process and eliminating the necessity of high temperatures and pressures in the process.

According to the invention there is provided a method of microscopic cleaning and sterilizing of bacterially contaminated articles which comprises the steps of completely immersing said articles in a cleaning solution as hereinbefore defined, cavitating said solution by the application of sonic energy, draining said solution and subjecting said articles to a bactericidal gas.

The invention will now be described by way of example with reference to the accompanying drawing the single figure of which is a schematic diagram of one embodiment of the invention.

In one mode in which the invention is to be practiced, the contaminated articles are placed in a container and the container is inserted in a sterilizing and cleaning vessel. A cleaning solution is pumped into the vessel to a level which at a minimum completely covers the articles.

The water of the cleaning solution may advantageously be distilled water but the invention should not be construed to be limited thereto. In the invention the wetting agent portion of the cleaning solution may be a detergent having surface-active and detergent properties. Any of a wide variety of detergents which have the above properties may be used, for example: a mixture of 80% Sodium Lauryl Sulfate and 20% Sodium Hexametaphosphate; a mixture of 75% Sodium Orthosilicate and 25% Trisodium Phosphate; a mixture of 45% Metasilicate, 25% Sodium Bicarbonate, 25% Tetrasodium Phosphate, and 5% Sodium Lauryl Sulfate; and a mixture of 14 grams of Sodium Lauryl Sulfate and 14cc Ammonium Hydroxide.

Detergent solutions of the following proportions may be used: a solution of 3 to 7 ounces of a mixture of 80% Sodium Lauryl Sulfate and 20% Sodium Hexametaphosphate in one gallon of water; a solution of 2 to 8 ounces of a mixture of 75% Sodium Orthosilicate and 25% Trisodium Phosphate in one gallon of water; a solution of 2 to 9 ounces of a mixture of 45% Sodium Metasilicate, 25% Sodium Bicarbonate, 25% Tetrasodium Phosphate and 5% Sodium Lauryl Sulfate in one gallon of water; a solution of 14 grams of Sodium Lauryl Sulfate, 14cc of Ammonium Hydroxide and one litre of water.

The detergent solution is subjected to sonic energy at a frequency and amplitude sufficient to produce cavitation of said solution, the term "cavitation" defines several types of action including one in which tiny bubbles present in the liquid and created by other actions, are made to collapse. Thus a cavitated detergent solution experiences these violent pressure changes, at myriads of microscopically spaced volumes of microscopic dimensions. Such pressure changes break up clusters of bacteria, separate the clump or chain grouping bacteria, disperse foreign encapsulating material, and move the solution in the vessel. The cleaning solution is drained from the vessel and the treated articles are spray rinsed with water, distilled water is not necessary in that the articles are visibly clean but not bacterially clean.

The sterilizing and cleaning vessel is filled

with a bactericidal gas. As used herein the word gas is generic to both gases and vapors and the use of either word shall mean elements in the non-liquid and non-solid state. In the present invention two bactericidal gases which may be used advantageously are Ethylene Oxide gas or Beta-propiolactone gas. The bactericidal atmosphere is maintained in the vessel for killing the microorganisms of both the spore or non-spore forming state. The bactericidal gas is evacuated from the vessel and the microscopically clean articles are removed from the container.

The above processes suggest that increased cavitational action is desirable. This is true but the violence of the action reaches an economical limit whereby increased cavitational action does not produce proportionate results. Subjected to an alternating force, such as is presented by sonic energy, the liquid is subjected to recurring reductions and increases in pressures during which bubbles are enlarged and then collapsed. The forces of cavitation depend upon the change in bubble dimensions. The degree of this dimensional change increases with sonic energy intensity if frequency is unchanged and it decreases with frequency if sonic energy intensity is unchanged. Further, if frequency and sonic energy intensity are unchanged, the degree of cavitation violence increases with surface tension of the cavitated liquid and decreases with vapor pressure.

Those skilled in the art use the terms "sonic" and "ultrasonic" frequencies, to include frequencies within the range of audible frequencies as well as those beyond that range. The term is used in that sense herein and is not limited to inaudible frequencies.

In practice the degree of cavitation is limited by dispersion of the sonic energy waves by the bubbles created in the cavitation process. After the sonic energy is increased to the threshold level of cavitation, further increase causes relatively low incremental increase in cavitation violence. The increased energy is dissipated primarily as heat whereby the temperature of the cavitated liquid is raised.

The energy threshold for cavitation in a given liquid while relatively constant at low frequencies, increases rapidly at higher frequencies. The result is that the lower limit for practicing the process is that the sonic energy input must exceed the cavitation threshold of the cavitated liquid. It has been found that the upper limit of sonic action is at that frequency and power at which the cavitation causes significant cellular damage or cellular rupture. Significant cellular damage or rupture will positively occur at such high levels of the combination of frequency and power at which no cavitation is present. No lower frequency limit is imposed but the frequency is advantageously kept below 50 kilocycles per second, below which threshold power levels are sufficiently low to preclude significant cellular damage or rupture of the bacteria either due to the cavitation or the compressional waves when there is no cavitation. By maintaining the frequency below 50 kilocycles per second the noise of an operating unit is kept to a minimum. At such operational frequencies and power as herein described the apparatus is of minimum size and relatively inexpensive.

With water as a constituent of the cleaning solution and at atmospheric pressure and the frequency less than 50 kilocycles per second, the power input must be in excess of the cavitational threshold power. For water this is one third watt per cubic centimeter of water to be cavitated.

Such variables as the pressure at which the invention is practiced and the surface tension and vapor pressure of the cavitated liquid only changes the threshold level of sonic energy required for cavitation. If the sonic frequency is held below 50 kilocycles per second, they do not substantially effect the process but are only important to the economics of sonic energy production as long as cavitation is maintained.

The following examples are set forth as illustrations of the invention and are not to be construed as limiting the invention.

EXAMPLE I

The microscopic cleaning and sterilization of instruments contaminated with spore forming and non-spore forming bacteria is accomplished by immersion of the contaminated instruments in a detergent solution consisting substantially of 3 to 7 ounces of a mixture of 70 to 85% Sodium Lauryl Sulfate and the remainder Sodium Hexametaphosphate and one gallon of water, cavitation of the detergent solution for 3 to 10 minutes by subjecting to sonic energy, subjecting the latter to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimetre of the solution, and rinsing the instruments in water and subjecting the instruments to Ethylene Oxide gas for 15 to 120 minutes.

EXAMPLE II

The microscopic cleaning and the sterilization of clinical instruments contaminated with dried blood, bone, enamel, and dentine, which contamination includes spore forming and non-spore forming bacteria, is accomplished by immersion of the contaminated instruments in a detergent solution consisting substantially of 2 to 8 ounces of a mixture of 65% to 85% Sodium Orthosilicate and the remainder Trisodium Phosphate and one gallon of water, cavitation of the detergent solution for 3 to 10 minutes by sub-

jection to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimetre of the solution and rinsing the instruments in water and subjecting the instruments to Beta-propiolactone gas for 15 to 120 minutes.

EXAMPLE III

The microscopic cleaning and the sterilization of clinical instruments contaminated with dried blood, bone, enamel, and dentine, which contamination includes spore forming and non-spore forming bacteria, is accomplished by insertion of the contaminated instruments in a vessel, filling the vessel to a level covering the instruments with a cleaning solution consisting substantially of 2 to 9 ounces of a mixture of 45% Sodium Metasilicate, 25% Sodium Bicarbonate, 25% Tetrasodium Phosphate, and 5% Sodium Lauryl Sulfate and one gallon of water, cavitating the detergent solution for 5 minutes by subjection to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of the solution. Draining the detergent solution from said vessel, spray washing the instruments with water, draining the water from said vessel. Filling the vessel with Ethylene Oxide gas, maintaining the gas in the vessel for 60 minutes at atmospheric pressure and temperature and evacuating the gas from the vessel and removing the instruments.

EXAMPLE IV

The microscopic cleaning and the sterilization of clinical instruments contaminated with dried blood, bone, enamel, and dentine, which contamination includes spore forming and non-spore forming bacteria, is accomplished by insertion of the contaminated instruments in a vessel and fill the vessel to a level covering the instruments with a cleaning solution consisting substantially of 14 grams of Sodium Lauryl Sulfate, 14cc of Ammonium Hydroxide and one litre of water, cavitating the detergent solution for 5 minutes by subjection to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of the solution, draining the detergent solution from said vessel, spray washing the instruments with water, draining the water from said vessel. Filling the vessel with Beta-propiolactone gas, maintaining the gas in the vessel for 40 minutes at atmospheric pressures and temperatures, and evacuating the gas from the vessel and removing the instruments.

Referring to the drawing there is shown a cleaning and sterilization system having a vessel 10 mounted on vessel mounting stand 11. Vessel 10 may advantageously comprise a substantially cylindrical section 12 having at one end thereof a permanent end closure 14 and the second end 15 disposed to receive door 16. Vessel 10 is mounted on stand 11 at three positions 18 and rigidly held thereto by any well known means (not shown). The portion of cylindrical section 12 which is joined to stand 11 will hereinafter be referred to as the bottom portion 19 of cylindrical section 12. Bottom portion 19 has an opening 20 disposed to receive transducer plate 21 which is held rigidly thereto by any well known means (not shown). Adequate sealing means 22 and 24 are provided for door 16 and transducer plate 21, respectively, to provide liquid and gas tight vessel 10, and a vessel capable of maintaining liquid and gas disposed therein at normal atmospheric pressures.

The top of vessel 10 has an opening 25 therethrough for a safety relief valve 26 which will exhaust the fluids within vessel 10 if a pressure build-up occurs due to a malfunction within the system or when fluids are put into the vessel 10 during the filling operations. In the bottom portion 19 of the vessel 10 and disposed within said vessel is basket support 28 rigidly fixed to the interior wall of the vessel 10. Removable wire basket 29 is shown resting on support 28 and has a wire mesh portion 30 of such size to hold the smallest parts to be placed therein but of such size not to interfere with the activity of the sonically activated liquid disposed within the vessel 10.

Gas is supplied to vessel 10 through port 31 in the bottom portion 19 of the vessel 10. Port 31 through pipe 32 is in fluid communication with shut-off valve 34. Valve 34 is in fluid communication with supply fitting 35 mounted in stand 11 by means of pipe 36. Supply fitting 35 is readily accessible to a mating element connected to the supply tank 38. Valve 34 has two positions (not shown) "fill" and "closed". In the "fill" position, valve 34 will permit the flow of fluid from tank 38 into vessel 10 and in the "closed" position, valve 34 will shut off such flow. Some liquid may settle in pipe 32 but such setting will not be detrimental to the operation of the system. Gas from tank 38 is supplied to vessel 10 under sufficient pressure to remove any settling material or liquid from the pipe 32.

Depending on the environment in which the cleaning and sterilization apparatus is to be used and the bactericidal gases employed, exhaust of the gases into the surrounding air by opening door 16 may not be desirable. Therefore, the top of vessel 10 is provided with an opening 39 therethrough for an exhaust valve 40 which may be connected to suitable means (not shown) for withdrawing gas from vessel 10.

Suspended from the top 41 of vessel 10 are a plurality of spray nozzles 42 which are connected to water supply line 44. Line 44 passes through the bottom portion 19 of vessel 10 to fitting 45 mounted in stand 11. Fitting 45 is readily accessible to a mating

element connected to a suitable water supply source 46.

The numerals 48 and 49 designate magnetostrictive transducers fixed to transducer plate 21 which is adapted to transmit the sonic or ultrasonic energy to the cleaning solution in the vessel. Within the scope of the invention any number of transducers may be employed depending upon the vessel structure and the liquid activation required. Permanent magnets 50 and 51 are interposed between the legs of the transducers 48 and 49 applying undirectional magnetisim to the transducers. Alternating magnetizing forces are applied to the transducers 48 and 49 by means of windings 52 and 54 which are connected by wires 55 and 56 to electrical plug 58. Plug 58 is mounted in stand 11 and is readily accessible to a mating element connected to sonic supply source 59. Mounting stand 11 is advantageously provided with ventilating holes 60 for cooling transducers 48 and 49. Cooling air is supplied to the transducer area by means of tubing 61 which is in fluid communication with fitting 62 mounted in stand 11. Fitting 62 is readily accessible to a mating element connected to a suitable air supply 64.

Liquid is supplied to and drained from vessel 10 through port 65 in the bottom portion 19 of the vessel 10. Port 65 through pipe 66 is in fluid communication with three way valve 68. Valve 68 is in fluid communication with supply fitting 69 mounted in stand 11 by means of pipe 70, pump 71, and pipe 72. Supply 69 is readily accessible to a mating element connected to the supply tanks 74. Pump 71 is disposed to receive fluid from tanks 74 and to force the fluid through valve 68 into vessel 10. Valve 68 is in fluid communication with drain fitting 75 by means of drain pipe 76. Drain fitting 75 is readily accessible to a mating element connected to a drain container 78. Three way valve 68 has three positions (not shown), "fill", "drain", and "closed". In the "fill" position valve 68 will permit the flow of fluid from pump 71 into vessel 10 and close off the flow of fluid to drain fitting 75. In the "closed" position, valve 68 will shut off the flow of all fluid through valve 68. In the "drain" position valve 68 will permit the flow of fluid from vessel 10 to drain fitting 75 and close off the flow of fluid from pump 71. Within the scope of the invention a structural modification may be made wherein pipe 32 is connected to pipe 66 immediately above three way valve 68. It is apparent that this modification will eliminate the settling of liquid in any of the pipes as in the case in pipe 32 as hereinabove described. The operation of valves 34 and 68 under this modification are apparent from the foregoing description of the valve operation.

The operation of the cleaning and sterilization system will hereinafter be described, the process defined in Example IV will be utilized in the description of operation but should not be construed to be limiting the invention to that process. The electrical plug 58 and the fittings 35, 45, 62, 69, and 75 are connected to suitable outlets as heretofore described. The contaminated articles are inserted in wire basket 29 and door 16 is closed.

Three way valve 68 is moved to the "fill" position whereby the cleaning solution consisting substantially of 14 grams of Sodium Lauryl Sulfate, 14cc of Ammonium Hydroxide, and one litre of water, will flow from supply tank 74 through pump 71, valve 68, port 65, and into vessel 10. Pump 71 forces the cleaning solution into the vessel until the desired level is reached when valve 68 is moved to the "close" position and all flow of liquid through port 65 is shut off.

Sonic supply source 59 is turned to operate and air supply 64 is turned on for cooling the transducers 48 and 49 during operation. Transducers 48 and 49 will transmit energy through transducer plate 21 and cavitate the cleaning solution in the vessel 10. Sonic supply source 59 is turned off after 5 minutes of operation together with air supply 64.

Three way valve 68 is turned to the "drain" position. The solution and the removed material will flow through port 65, drain fitting 75, and into drain container 78.

Valve 68 is turned to the "closed" position after vessel 10 is emptied and water supply 46 is turned to operate. Water will flow from supply 46 through fitting 45 and supply line 44 to spray nozzles 42. The spray from nozzles 42 is directed across the articles disposed in basket 29. Water supply 46 is turned off and three way valve 68 is turned to the "drain" position. Valve 68 is turned to the "closed" position after vessel 10 is emptied.

Valve 34 is turned to the "open" position whereby Beta-propiolactone gas flows from supply tank 38 through fitting 35, pipe 36, valve 34, pipe 32, port 31, and into vessel 10. As the gas passes into vessel 10 a slight pressure will build up in the vessel 10 and safety valve 26 will open. The air in the vessel 10 will exhaust through valve 26 as gas is admitted to the vessel. Some of the gas mixed with the air will be lost through valve 26 to the atmosphere. Valve 34 is closed when the vessel 10 is substantially filled with the gas and safety valve 26 will automatically close as the pressure in the vessel 10 drops back to ambient pressure. The articles in wire basket 29 are left exposed to the gas for 40 minutes. The gas is evacuated from the vessel 10 through exhaust valve 40 as hereinbefore described.

The cleaned and sterilized instruments are removed from basket 29.

WHAT WE CLAIM IS:—

1. The method of microscopic cleaning and sterilizing of bacterially contaminated articles which comprises the steps of completely immersing said articles in a cleaning solution as hereinbefore defined, cavitating said solution by the application of sonic energy, draining said solution and subjecting said articles to a bactericidal gas.

2. The method as claimed in claim 1 including the step of rinsing said articles with water before subjecting said articles to the bactericidal gas.

3. The method as claimed in claim 1, in which the cleaning solution includes a wetting agent which is a detergent.

4. The method as claimed in claim 1, in which said bactericidal gas is Ethylene Oxide gas.

5. The method as claimed in claim 1, in which said bactericidal gas is Beta-propiolactone gas.

6. The method as claimed in any of the preceding claims, in which the sonic energy has a frequency less than 50 kilocycles per second.

7. The method as claimed in claim 3, in which the detergent is either a mixture of 80% Sodium Lauryl Sulfate and 20% Sodium Hexametaphosphate, a mixture of 75% Sodium Orthosilicate and 25% Trisodium Phosphate, a mixture of 45% Sodium Metasilicate, 25% Sodium Bicarbonate, 25% Tetrasodium Phosphate and 5% Sodium Lauryl Sulfate or a mixture of 14 grams of Sodium Lauryl Sulfate and 14cc Ammonium Hydroxide.

8. The method of microscopic cleaning and sterilizing as claimed in claim 1 of articles contaminated with bacteria of the spore and non-spore forming type which comprises the steps of immersing the contaminated articles in a cleaning solution consisting of 3 to 7 ounces of a mixture of 70 to 85% Sodium Lauryl Sulfate and the remainder Sodium Hexametaphosphate and one gallon of water, cavitating said cleaning solution for 3 to 10 minutes by subjecting the latter to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of said solution, rinsing said articles in water and subjecting said articles to Eethylene Oxide gas for 15 to 120 minutes.

9. The method of microscopic cleaning and sterilizing as claimed in claim 1 of clinical articles contaminated with dried blood, bone, enamel or dentine which contamination includes bacteria of the spore and non-spore forming type which comprises the steps of immersing the contaminated articles in a cleaning solution consisting of 2 to 8 ounces of a mixture of 65% to 85% Sodium Orthosilicate and the remainder Trisodium Phosphate and one gallon of water, cavitating said cleaning solution for 3 to 10 minutes by subjecting the latter to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of said solution, rinsing said articles in water and subjecting said articles to Beta-propiolactone gas for 15 to 120 minutes.

10. The method of microscopic cleaning and sterilizing as claimed in claim 1 of clinical articles contaminated with dried blood, bone, enamel or dentine which contamination includes bacteria of the spore and non-spore forming type which comprises the steps of inserting the contaminated articles in a vessel, filling the vessel to a level covering the articles with a cleaning solution consisting of 2 to 9 ounces of a mixture of 45% Sodium Metasilicate, 25% Sodium Bicarbonate, 25% Tetrasodium Phosphate, and 5% Sodium Lauryl Sulfate and one gallon of water, cavitating the cleaning solution for 5 minutes by subjecting the latter to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of said solution, draining the cleaning solution from the vessel, spray washing the articles with water, draining the water from the vessel, filling the vessel with Ethylene Oxide gas, maintaining the gas in the vessel for 60 minutes at atmospheric pressure and ambient temperature, evacuating the gas from the vessel and removing the articles.

11. The method of microscopic cleaning and sterilizing as claimed in claim 1 of clinical articles contaminated with dried blood, bone, enamel or dentine which contamination includes bacteria of the spore and non-spore forming type which comprises the steps of inserting the contaminated articles in a vessel, filling the vessel to a level covering the articles with a cleaning solution consisting of 14 grams of Sodium Lauryl Sulfate, 14cc of Ammonium Hydroxide and one liter of water, cavitating the cleaning solution for 5 minutes by subjecting the latter to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of said solution, draining the cleaning solution from the vessel, spray washing the articles with water, draining the water from the vessel filling the vessel with Beta-propiolactone gas, maintaining the gas in the vessel for 40 minutes at atmospheric pressure and temperature, evacuating the gas from the vessel and removing the articles.

12. An apparatus for microscopic cleaning and sterilizing of bacterially contaminated articles comprising a vessel equipped with means for supplying and withdrawing liquid to and from said vessel, with a separate means for supplying gas to said vessel, with a plurality of sonic or ultrasonic transducers attached in wave transmitting relation with

said vessel and with means for spraying water in said vessel.

13. The method of microscopic cleaning and sterilizing of bacterially contaminated articles as claimed in claim 1 substantially as herein described.

14. An apparatus for microscopic cleaning and sterilizing of bacterialy contaminated articles constructed and adapted to operate substantially as herein described with reference to the accompanying drawing.

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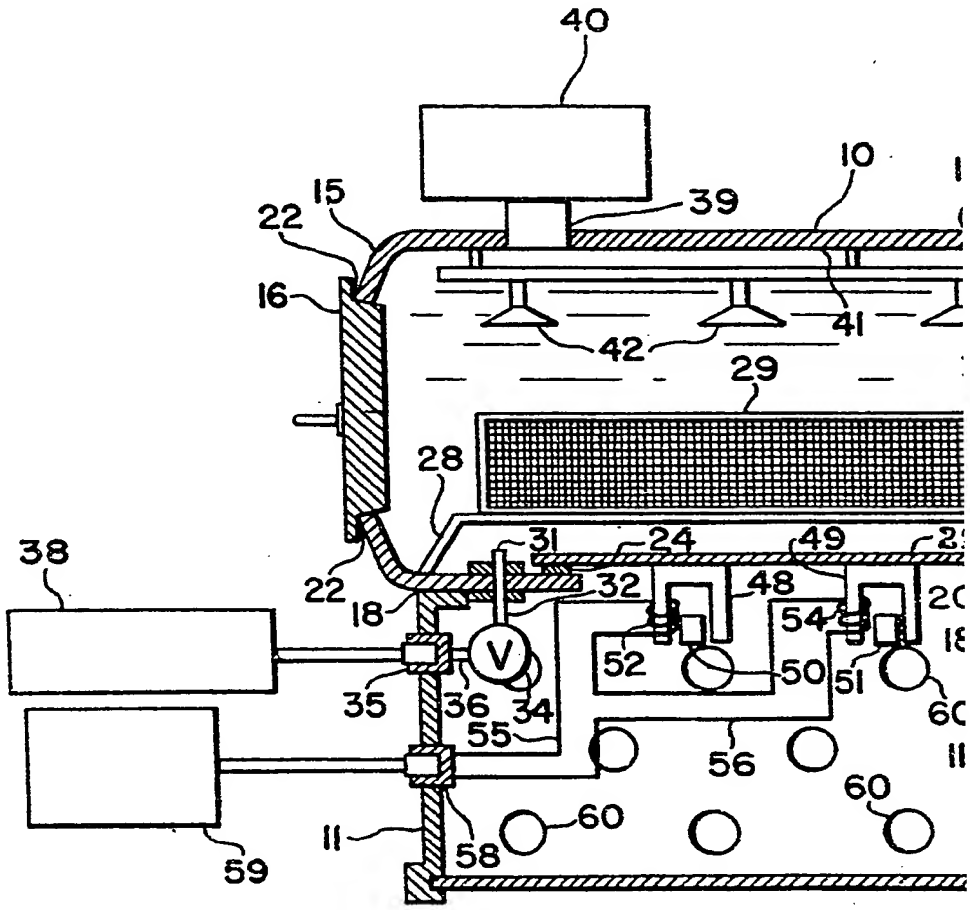
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1 SHEET

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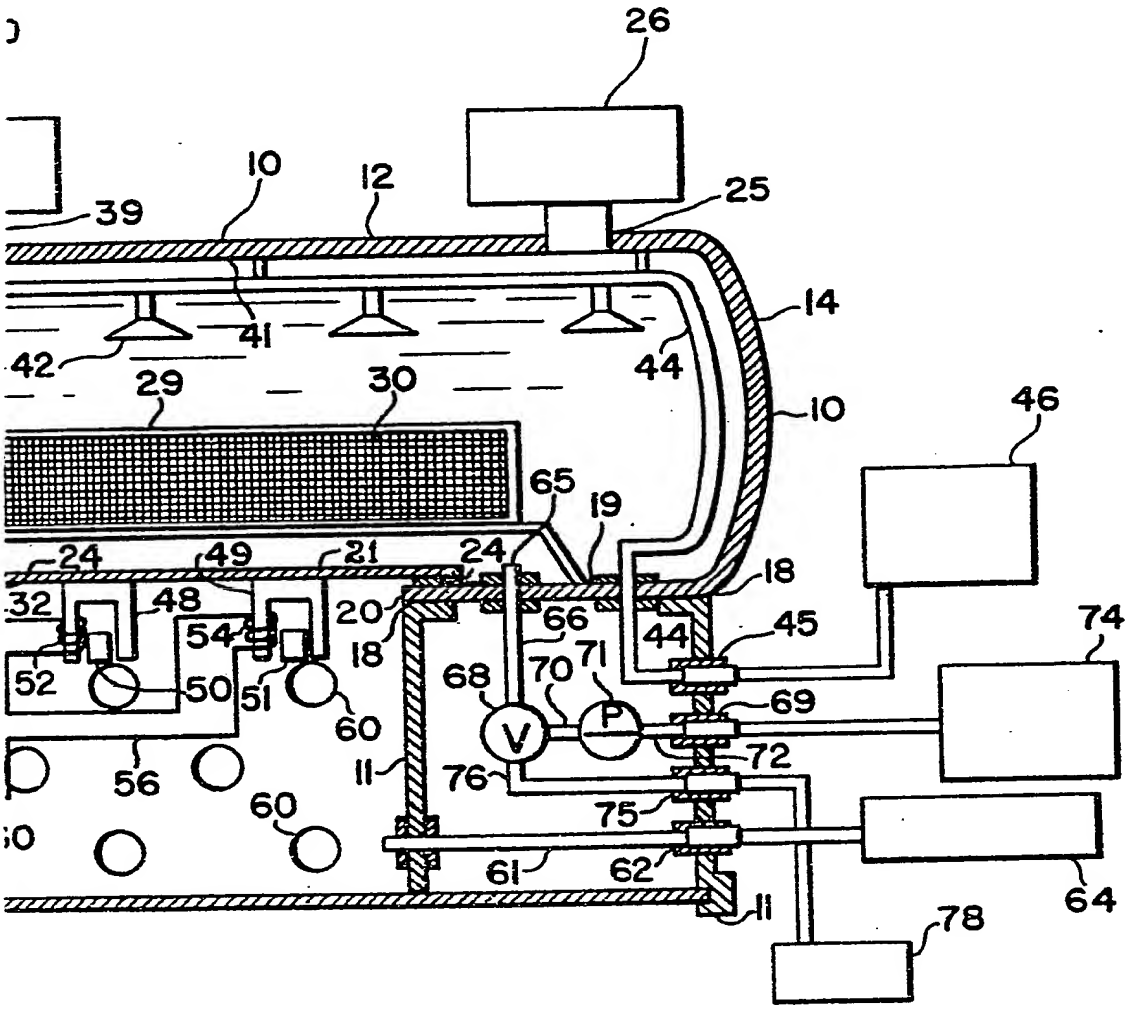

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